NETWORK COMMUNICATION SYSTEM AND METHOD OF DYNAMIC ROUTING

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BACKGROUND OF THE INVENTION

5   Field of the Invention

The invention relates in general to a network communication system and method of dynamic routing, and more particularly to a network communication system and method for efficiently determination of a message-transporting path

10   between two hosts on the Internet. When two hosts cannot effectively connect to each other, the network communication system of the invention uses the method of dynamic routing to find the most suitable routing host.

Description of the Related Art

15   At present on the Internet, the network communication system that transports messages asynchronously (store and forward) between two hosts transport messages routinely according to either pre-built message-transporting paths or related data of network connection. The former is static

20   routing while the latter is dynamic routing.

The network communication system transporting messages

by the static routing way has to include a static routing table for recording message-transporting paths called routing paths between any two hosts on the Internet. When a sending host sends a message to a destination host, the routing path is

5   the order of passing hosts that aid to transport messages to the destination host by storing and forwarding. When the sending host cannot directly transport messages to the destination host, the network communication system retrieves a routing path between the two hosts from a static routing

10 table. Messages are then transported to the destination host via the order of passing hosts of the routing path.

Referring to FIG. 1, it shows a schematic diagram of a network 10. As shown in FIG. 1, there are five hosts, A, B, C, D, and E, on the network 10. According to connection

15 relationship of any two hosts, a static routing table can be built as shown in the following Table 1.

Table 1

Sending host	Destination host	Routing path
A	B	
A	C	
A	D	B
A	E	C
B	A	

B	C	A
...	...	...
C	E	
...	...	...

Table 1 shows that host A cannot directly connect to host

E. Therefore, when host A tries to send messages to host E,

the network communication system retrieves a routing path from

5   the Table 1. As shown in Table 1, messages of host A have to

be routed by host C before arriving at host E. Accordingly,

host A first routes messages to host C and then host C transports

the messages to host E.   However, there are generally more than

one routing path between two hosts on the Internet. As shown

10   in FIG. 1, an alternate connecting path from host A to host

E is to go through host B then host D before arriving at host

E. If the bandwidth between host A and host C is narrow, the

transporting speed becomes slow. At this time, the alternate

routing path may be faster instead. However, since this

15   alternate path is not set in Table 1, the messages cannot be

routed this way. Thus it can be seen that the static routing

way is not flexible and cannot dynamically change the routing

path according to practical network situation. As such, static

routing cannot route messages in the optimum path and

20   consequently is not efficient.

The network communication system transporting messages by the dynamic routing way can use pre-built related data of network connection to find a suitable message-transporting path. The network communication system has to first build the related data of network connection, such as network topology, bandwidth, or cost of connection. When a sending host tries to transport messages to a destination host, the network communication system uses an algorithm to find a suitable routing path. The algorithm can be the minimum-cost or shortest-path method. The network communication system can dynamically choose to use either method to produce different routing paths.

According to connection relationship of any two hosts on the network 10 in FIG. 1, the network communication system can build related data of network connection between any two hosts shown in the following Table 2.

Table 2

Host	Host	Bandwidth	Cost
A	B	10Mbps	1
A	C	64Kbps	3
B	D	1Mbps	2
C	D	10Mbps	1
C	E	1Mbps	2

| D | E | 1 0Mbps | 1 |

The data established in Table 2 is a network topology, i.e. connection relationship between any adjacent hosts. The bandwidth of network connection of any adjacent hosts are built in Table 2 and the costs are defined according to the bandwidth. The higher the cost is, the longer the transporting time is. Likewise, the lower the cost is, the faster the speed of network transportation is and the shorter the transporting time is. The network communication system transporting messages by the dynamic routing way has to pre-build a table of network connection, such as Table 2.

Table 2 shows that host A and host E cannot directly build a connection. Accordingly, when the sending host A tries to transport messages to the destination host E, the network communication system first retrieves a message-transporting path from Table 2. The method of selecting a routing path can be based on practical network situation to find a suitable routing path. In general, the method of selecting a routing path is either the minimum-cost or shortest-path method. The shortest path is a path with minimum routing hosts between the sending host to the destination host. If the shortest-path method is used, the routing is only through host C. However, the cost of this routing path is five. If the minimum cost

method is used, the routing path through hosts B and then D

is selected since the cost is only four. As a result, when

routing messages, it is a property of dynamic routing that

the network communication system can select an algorithm to

5   determine a suitable routing path according to practical

network situation.

However, regardless of which, static or dynamic, routing

is in operation, related data of network connection, such as

Tables 1 and 2, have to be pre-built by network administrators.

10   Two disadvantages to this are:

(1) The network communication system cannot automatically

and efficiently react to the changing network situations in

time (i.e. increase of bandwidth, network disconnections,

and/or breakdown of hosts).

15   (2) The workload of network administrators increases when

the network situations change.

SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide

a network communication system for efficiently determining

20   a message-transporting path between two hosts on the Internet

and a method of dynamic routing. When the two hosts cannot

effectively build a connection, the network communication

system of the invention uses the method of dynamic routing

to find the most suitable routing host. It is not necessary

for the network communication system and method of the invention

to build up the related data of network connection in advance.

5   The invention can automatically and efficiently react to

network situations to find the optimum message-transporting

path. That is, the invention can determine the most suitable

routing host(s) to proceed to route messages with. Thus the

invention not only reduces the workload of network

10   administrators but also efficiently react to changes in

practical network situations to dynamically change routing

paths in order to enhance the efficiency of transportation.

According to the above-identified objects of the invention,

when two hosts cannot effectively build a connection on the

15   Internet, the network communication system of the invention

uses the method of dynamic routing to look up the most suitable

routing host. The method includes the following steps. (a)

A sending host directly transports messages to a destination

host. If the sending host can effectively build a network

20   connection and transport messages to the destination host,

the method ends, otherwise the method proceeds to step (b).

(b) The system finds a series of routes that can be effectively

connected and past from the sending host to the destination

host. The Internet protocol (IP) addresses of the series of

25   routers are successively put into a list. (c) The system judges

whether the list includes at least one IP address. If so, the method proceeds to step (d), otherwise the method proceeds to step (i). (d) The system moves a pointer to point to the last IP address of the list. (e) The system finds a domain

5   of the IP address presently pointed by the pointer. (f) If the system finds a message-routing-in-charge host in the domain, the method proceeds to step (g), otherwise the method proceeds to step (h). (g) The sending host transports the messages to the message-routing-in-charge host. The

10   message-routing-in-charge host is regarded as another sending host and then the method proceeds to step (a). (h) If the IP address pointed by the pointer is the first IP address of the list, the method proceeds to step (i), otherwise the method proceeds to step (j). (i) The sending host keeps the messages

15   for a predetermined time and then the method proceeds the step (a). (j) The system moves the pointer to point to an IP address previous to that presently pointed in the list and then the method proceeds the step (e).

BRIEF DESCRIPTION OF THE DRAWINGS

20   Other objects, features, and advantages of the invention will become apparent from the following detailed description of the preferred but non-limiting embodiments. The description is made with reference to the accompanying drawings, in which:

        Figure 1 (Prior Art) is a schematic diagram of a network;

Figure 2 is a sketch diagram of a message-transporting path between a sending host and a destination host on the Internet;

Figure 3 is a functional block diagram of the network
5   communication system of the invention; and

Figure 4 is a flowchart of the method of dynamic routing of the network communication system in Figure 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The design of the invention is to make use of existing
10   services of the Internet to achieve the function of automatically and efficiently routing messages. It is not necessary for the network communication system to pre-build a data of network connection. The existing services of routers on the Internet are enlisted to obtain data to generate routing
15   paths.

Referring to FIG. 2, it shows the sketch diagram of a message-transporting path between a sending host 20 and a destination host 24 on the Internet. As shown in FIG. 2, the sending host 20 routes messages to the destination host 24
20   via several routers R1, R2, R3,…, and Rn. Every router R1, R2, R3,…, and Rn respectively has a corresponding Internet protocol (IP) address IP1, IP2, IP3,…, and IPn which is in

a corresponding domain. Every domain may include a
corresponding host Si (i ∈ {1,2,3,…,n}) to route messages.

Referring simultaneously to FIG. 3 and FIG.4 where Figure
3 illustrates the functional block diagram of the network
5   communication system 12 of the invention and FIG. 4 shows the
flowchart of the method of dynamic routing of the network
communication system 12. As shown in FIG. 3, the network
communication system 12 includes a tracing means 14, memory
means 15, pointing means 16, judging means 17, and searching
10   means 18.

In step 301, the sending host 20 tries to transport messages
to the destination host 24. If the sending host 20 does not
successfully build a connection to the destination host 24,
the method proceeds to step 302. If the sending host 20
15   effectively sends messages to the destination 24, the method
ends.

In step 302, the tracing means 14 uses a method, same
as the tracing path program (traceroute), to find a series
of routers between the sending host 20 and the destination
20   host 24. The IP addresses IP1, IP2, IP3,…, IPn of the routers
are successively put into a list of IP addresses and stored
in the memory means 15.

The sending host 20 tries to send IP datagrams to the

destination host 24 in order to obtain the series of routers
R1, R2, R3,…, and Rn between the sending host 20 and the
destination host 24. The head of an IP datagram includes a
time-to-live (TTL) field and every router that receives the

5   IP datagram subtracts one from the value of the TTL field.
Therefore, the value of the TTL field can be used to count
how many routers the IP datagram passes. When a router receives
an IP datagram having a TTL field with a value of zero, the
router abandons the IP datagram and sends back a time-out message

10   of Internet Control Message Protocol (ICMP) to the sending
host. Accordingly, the sending host can obtain an IP address
of the router by receiving an IP datagram including the ICMP
time-out message.

For example, the sending host 20 tries sends an IP datagram

15   having an TTL field with a value of one to the destination
host 24. Router R1 first receives the IP datagram and subtracts
one from the value of the TTL field.   Then the router R1 abandons
the IP datagram and sends back an ICMP time-out message to
the sending host 20. The IP address IP1 of the first router

20   R1 of the routing path is then obtained. The sending host 20
then sends an IP datagram having a TTL field with a value of
two to the destination host 24. The transporting path of the
IP datagram first passes router R1 which subtracts one from
the value of the TTL field of the IP datagram. Next, router

25   R2 receives the IP datagram and subtracts one from the value

of the TTL field again.   Router R2 then abandons the IP datagram

and sends back an ICMP time-out message to the sending host

20.   Accordingly, the sending host 20 obtains the IP address

IP2 of the router R2.   The sending host 20 repeatedly executes

5   the above steps until the sending host 20 does not receive

any ICMP time-out message; that is, the IP datagram is unable

to be transported to next router.   The network communication

system 12 then successively puts the IP addresses IP1, IP2,

IP3,…, IPn of the series of routers R1, R2, R3, …, Rn into

10   the list of IP addresses.

In step 303, the judging means of the network communication

system 12 judges whether the list includes at least an IP address.

If so, the method proceeds to step 304, otherwise the method

proceeds the step 309 whereby the messages are kept in the

15   sending host 20 for a predetermined time before the method

proceeds to step 301.

In step 304, the pointing means 16 moves a pointer to

point to the IP address IPn of the last router Rn of the list.

Then, the method proceeds to step 305.

20   In step 305, the searching means 18 uses the Domain Name

Service (DNS) to find a domain of the IP address of the router

Rn pointed by the pointer.

Next, in step 306, the searching means 18 uses the DNS

to find the message-routing-in-charge host Sn in the domain of the IP address IPn. If the message-routing-in-charge host Sn is found, the method proceeds to step 307 where the sending host 20 sends the messages to the message-routing-in-charge host Sn. Otherwise the method proceeds to step 308.

In step 308, the judging means 17 judges whether every IP address of the list has been searched. That is, the judging means 17 judges whether the pointer is moved to point to the IP address of the first router of the list. If so, it means that there is no host that can route the messages in the domains of IP addresses IP1, IP2, IP3,…, IPn of corresponding routers R1, R2, R3, …, Rn. The method then proceeds to step 309. In step 309, the messages are kept in the sending host 20 for a predetermined time, and then the method proceeds to the step 301. If the pointer does not point to the IP address of the first router, the method proceeds to step 310.

In step 310, the pointing means 16 of the network communication system 12 moves the pointer to point to a previous IP address of the list. Then the method proceeds to step 305 and the searching means 18 keeps on searching for a host Si that can route messages.

There are two methods by which the searching means 18 to use the DNS to look up a message-routing-in-charge host in a specified domain.

(1) An IP address of a message-routing host is registered beforehand in the Well Know Service (WKS) record of the DNS. The system can use a way of querying the WKS record to find the IP address of the message-routing-in-charge host.

5   (2) In the DNS, a name of message-sending service is regarded as an alias of the message-routing host. The system can then use the name of message-sending service as a querying name to find the IP address of the message-routing-in-charge host. For example, WWW is regarded as an alias of the World

10   Wide Web service and SMTP is regarded as an alias of the Simple Mail Transfer Protocol service.

In step 307, after the sending host 20 transports the messages to the message-routing-in-charge host Si, the host Si is regarded as another sending host. After waiting for a

15   predetermined time, the method proceeds to step 301 and keeps on transporting the messages to the destination host 24.

Additionally, in step 309, because the network communication system 12 does not find any host that can aid to route the message in the domains of all routers on the routing

20   path, the messages are kept in the present sending host 20. After waiting for a predetermined time, the method proceeds to step 301 and keeps on transporting the messages to the destination host 24.

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Generally, any two hosts on the Internet can directly connect to each other. Accordingly, the method of dynamic route of the invention can be applied to the following two situations:

(1) Both the sending host and destination host connect to the Internet by a dial-up network and both hosts do not simultaneously connect to the Internet every now and then. Therefore, the sending host has to transport messages to a routing host permanently connected to the Internet and then the routing host sends messages to the destination host.

(2) The dedicated lines respectively connected from the domain of the sending host and domain of the destination host to the Internet are congested in different time slots. Therefore, the sending host can transport messages to a routing host connecting to the Internet when the dedicated line of the domain of the sending host is not congested. The routing host can then send messages to the destination host when the dedicated line of the domain of the destination host is not congested.

As a result, when the sending host and destination host do not directly and efficiently build a connection, the sending host can first transport the message to a routing host that is nearer to the destination host. The routing host then sends the message to the destination host.

Advantages of the network communication system and method of dynamic routing in the above description of the embodiment of the invention are as follows:

(1) Network administrators need not additionally build
5   related data of network connection except registering a message-routing host in the DNS.

(2) The invention can efficiently react to practical situations of the Internet to find the most suitable message-routing host because the invention can dynamically
10   and efficiently find a series of router effectively connected. Between two hosts, according to different practical situations of the Internet, the invention can find different series of routers, i.e. different message-transporting paths.

(3) If the sending host and destination host are not
15   permanently connected to the Internet, the sending host can proceed the routing action via another routing host permanently connected to the Internet in order to effectively transport messages to the destination host.

While the invention has been described by way of example
20   and in terms of a preferred embodiment, it is to be understood that the invention is not limited thereto. On the contrary, it is intended to cover various modifications and similar arrangements and procedures, and the scope of the appended

claims therefore should be accorded the broadest

interpretation so as to encompass all such modifications and

similar arrangements and procedures.